BROOKHAVEN NATIONAL LABORATORY

Work Permit # DRL-2014-001
Work Order # ___
Job# ___ Activity# ___

See "Instructions for Filling out the Work Permit" contained in the Work Planning and Control for Experiments and Operations Subject Area.

1. Work request WCC fills out this section. ☐ **Standing Work Permit**

Requester: Don Lynch	Date: 2/25/2014	Ext.: 2253	Dept/Div/Group: PO/PHENIX
Other Contact person (if different from requester): Carter Biggs			Ext.: 7515
Work Control Coordinator: Don Lynch		Start Date: 2/25/2014	Est. End Date: 03/31/2014
Brief Description of Work: Installation of Partial MPC-Ex Detector FEM's and Electronics Control rack			
Building: 1008	Room: IR	Equipment: MPC-Ex (South partial)	Service Provider: PHENIX technicians and sPHENIX experts

2. WCC, Requester/Designee, Service Provider, and ESS&H (as necessary) fill out this section or attach analysis

ESS&H ANALYSIS

Radiation Concerns	☒ None	☐ Activation	☐ Airborne	☐ Contamination	☐ Radiation	☐ NORM	☐ Other
☐ Special nuclear materials involved, notify Isotope Special Materials Group			☐ Fissionable/Radiological materials involved, notify Laboratory Nuclear Safety Officer			
Radiation Generating Devices:	☐ Radiography	☐ Moisture Density Gauges	☐ Soil Density Gauges	☐ X-ray Equipment		

Safety and Security Concerns				
☐ None	☐ Explosives	☐ Transport of Haz/Rad Material	☐ Pressurized Systems	
☐ Adding/Removing Walls or Roofs	☐ Critical Lift	☐ Fumes/Mist/Dust*	☐ Magnetic Fields*	☐ Railroad Work
☐ Asbestos*	☐ Cryogenic	☐ Heat/Cold Stress	☐ Nanomaterials/particles*	☒ Rigging
☐ Beryllium*	☐ Electrical	☐ Hydraulic	☐ Noise*	☐ Silica*
☐ Biohazard*	☒ Elevated Work	☐ Lasers*	☐ Non-ionizing Radiation*	☐ Security Concerns
☐ Chemicals/Corrosives*	☐ Excavation	☐ Lead*	☐ Oxygen Deficiency*	☐ Suspect/Counterfeit Items
☐ Confined Space*	☐ Ergonomics*	☒ Material Handling	☐ Penetrating Fire Walls	☐ Vacuum
* Safety Health Rep. Review Required	☐ Haz, Rad, Bio Material Exceed DOE 151.1-C Levels - Contact OEM			☐ Other:

Environmental Concerns			
	☒ None	☐ Work impacts Environmental Permit No.	
☐ Atmospheric Discharges (rad/non-rad)	☐ Land Use Institutional Controls	☐ Soil Activation/contamination	☐ Waste-Mixed
☐ Chemical or Rad Material Storage or Use	☐ Liquid Discharges	☐ Waste-Clean	☐ Waste-Radioactive
☐ Cesspools (UIC)	☐ Oil/PCB Management	☐ Waste-Hazardous	☐ Waste-Regulated Medical
☐ High water/power consumption	☐ Spill potential	☐ Waste-Industrial	☐ Underground Duct/Piping
Waste disposition by:			☐ Other
Pollution Prevention (P2)/Waste Minimization Opportunity:	☒ No ☐ Yes		

FACILITY CONCERNS			
	☒ None	☐ Intermittent Energy Release	
☐ Access/Egress Limitations	☐ Electrical Noise	☐ Potential to Cause a False Alarm	☐ Vibrations
	☐ Impacts Facility Use Agreement	☐ Temperature Change	☐ Other
☐ Configuration Management	☐ Maintenance Work on Ventilation Systems	☐ Utility Interruptions	

WORK CONTROLS

Work Practices

☐ None	☐ Exhaust Ventilation	☒ Lockout/Tagout	☐ Spill Containment	☐ Security (see Instruction Sheet)
☒ Back-up Person/Watch	☐ HP Coverage	☐ Posting/Warning Signs	☐ Time Limitation	☐ Other
☐ Barricades	☐ IH Survey	☐ Scaffolding-requires inspection	☐ Warning Alarm (i.e. "high level")	☐ Electrical Inspection Required

Personal Protective Equipment

☐ None	☐ Ear Plugs	☒ Gloves as appropriate	☐ Lab Coat	☒ Safety Glasses as appropriate
☐ Coveralls	☐ Ear Muffs	☐ Goggles	☐ Respirator*	☐ Safety Harness

☐ Disposable Clothing	☐ Face Shield	☒ Hard Hat, while crane in use	☐ Shoe Covers	☒ Safety Shoes as appropriate	☐ High visibility cloths/vest	☐ Other

Permits Required (Permits must be valid when job is scheduled.)

☒ None	☐ Cutting/Welding	☐ Impair Fire Protection Systems
☐ Concrete/Masonry Penetration	☐ Digging/Core Drilling	☐ Rad Work Permit-RWP No
☐ Confined Space Entry	☐ Electrical Working Hot	☐ Other

Dosimetry/Monitoring

☒ None	☐ Heat Stress Monitor	☐ Real Time Monitor	☐ TLD
☐ Air Effluent	☐ Noise Survey/Dosimeter	☐ Self-reading Pencil Dosimeter	☐ Waste Characterization
☐ Ground Water	☐ O_2/Combustible Gas	☐ Self-reading Digital Dosimeter	☐ Other
☐ Liquid Effluent	☐ Passive Vapor Monitor	☐ Sorbent Tube/Filter Pump	

Training Requirements (List specific training requirements)

PHENIX Awareness, CA Access or Equiv. Scaffold Training,

Based on analysis above, the Review Team determines the risk, complexity, and coordination ratings below:				**If using the permit when all hazard ratings are low, only the following need to sign: (Although allowed, there is no need to use back of form)**	
ESS&H Risk Level:	☒ Low	☐ Moderate	☐ High	WCC:	Date:
Complexity Level:	☒ Low	☐ Moderate	☐ High	Service Provider:	Date:
Work Coordination:	☐ Low	☒ Moderate	☐ High	Authorization to start	Date:
				(Department/Division, or their equivalent, Sup/WCC/Designee)	

3. Both work requester and service provider contribute to work plan (use attachments for detailed plans)

Work Plan (procedures, timing, equipment, scheduling, coordination, notifications, and personnel availability need to be addressed in adequate detail): See attached Procedure.
Special Working Conditions Required (e.g., Industrial Hygiene hold points or other monitoring) None
Notifications to operations and Operational Limits Requirements: None
Post Work Testing, Notification or Documentation Required:

Job Safety Analysis Required: ☐ Yes ☒ No	Review Done: ☒ in series ☐ team

Reviewed by: * Primary Reviewer signature means that the Review Team members were appropriate for the work that was planned, the Team visited the job site, hazards and risks that could impact ESS&H have been considered and controls established according to BNL requirements. In addition, this signature indicates that applicable JRAs, FRAs, as well as other planning documents have been reviewed and training requirements have been identified and recorded on this permit.

Title	Name (print)	Signature	Life #	Date
ES&H Professional				
F&O Facility Project Manager				
Service Provider				
Work Control Coordinator	Don Lynch		20146	
Safety Health Representative				
Research Space Manager				
Other				
Other (PHENIX Escort)				
Required Walkdown Completed				
*Primary Reviewer				

4. Job site personnel (Supervisor and workers) fill out this section.

Note: Signature indicates personnel performing work have read and understand the hazards and permit requirements (including any attachments) and all training required for this permit is current/complete. Job Supervisor/Contractor Supervisor signatures also includes verification that worker training required for this permit is current/complete.

Job Supervisor:		Contractor Supervisor:	
Workers:	Life#:	Workers :	Life#:

Workers are encouraged to provide feedback on ESS&H concerns or on ideas for improved job work flow. Use feedback form or space below.

5. Department/Division, or their equivalent, Line Manager or Designee

Conditions are appropriate to start work: (Permit has been reviewed, work controls are in place and site is ready for job.)

Name:	Signature:	Life#:	Date:

6. Worker provides feedback.

Worker Feedback (use attached sheets as necessary)

a) WCM/WCC: Are there any changes as a result of worker feedback? ☐ Yes ☐ No

Note: See Work Planning and Control for Experiments and Operations Subject Area section 2.6.

7. Post Job Review/Closeout: Work Control Coordinator (authorizing dept.) checks quality of completed permit and ensures the work site is left in an acceptable condition. (WCC can delegate clean up of job site to work supervisor.) The WCC ensures that the change process to update drawings, placards, postings, procedures, etc., is initiated, if necessary.

Name:	Signature:	Life#:	Date:
Comments:			

Attachment to W.P. #DRL-2014-01 February 25, 2014

MPC-Ex Electronics Installation: Control Rack and Front End Modules

Introduction

The Muon Piston Calorimeter (MPC) Extension, or MPC-EX, is a Si-W pre-shower detector that will be installed in front of the existing PHENIX MPC's in both the north and the south Muon Magnets. This detector consists of eight layers of Si "minipad" sensors interleaved with tungsten absorber and enables the identification and reconstruction of $\pi 0$ mesons at energies up to ~80 GeV.

The PHENIX Collaboration will install this new detector subsystem prior to run 15, but an engineering run consisting of a partial detector installed in the south Muon Magnet piston hole is planned for run 14. This document describes the work plan to install the control rack and front end modules

MPC-Ex Design

The MPC-Ex design consists of 8 layers (plates) of 2.0 mm thick tungsten spaced 4.5 mm apart. There are upper and lower halves to the MPC-Ex and north and south stations in the north and south Muon Magnets, respectively. On to each tungsten plate a carrier board is adhered. To each carrier board 12 micromodules consisting of a minipad silicon sensor sandwiched and glued between a ceramic base and a Dual SVX-4 Readout Card. The card is then wirebonded to the silicon sensor. On the side farthest from the PHENIX IP, a Delrin plate will be attached provide a light tight closure beyond the last layer of carrier board.

Assembly of the MPC-Ex detectors requires gluing fixtures for the micromodules and for the carrier board/tungsten plate lamination.

The 8 layers are stacked up and spaced using threaded rods and threaded spacers, then the upper and lower ends are capped with support covers. Low voltage distribution boards are mechanically attached to the upper and lower support covers. Each Carrier board has power connections between itself and the LV distribution board and bias voltage connections. The LV distribution boards have power and communication cables to a control racks mounted on the north and south MuTrigger racks.

In addition, each carrier board has 2 ribbon cable pig tails, which connect via a 2-meter ribbon cable to a front end module. The front end module in turn connects back to the control rack via flat LVDS cable. Communication from the rack room to the MPC-Ex control racks will be via fiber optic cables.

Cooling for the MPC-Ex will be accomplished using the PHENIX dry air system, which is already providing cooling for the MPC detectors.

In order to accommodate the MPC-Ex, minor modifications to existing equipment is required as follows:

1. The "bellows spreader" which prevents lateral and twisting movement of the bellows in the south Muon Magnet (MMS) (while allowing unimpeded longitudinal movement) will be removed and replaced with a new design, which has a smaller radial footprint to allow maximization of detector coverage. This new design is referred to as an "anti-squirm" device to more accurately describe its function. (Note: there is no bellows spreader in the north Muon Magnet [MMN], and as such no anti-squirm device is required in the north magnet.

2. Light collection boxes for the existing MPC's will be moved to the MuID station 1 front end electronics plate (FEE plate) on both north and south detector stations. MuID cables and components on the FEE plate will be relocated / rerouted as necessary to accommodate the light collection boxes.

3. MPC Fiber optic extensions and adapters will be fabricated to allow the light box relocations.

4. Other minor modifications on the side panels of the MMS and MMN to accommodate mounting of MPC-Ex Front End modules will be undertaken as necessary.

Mounting clips are designed to attach to the walls of the MMS and MMN piston cavities to precisely locate the MPC-Ex in the piston holes. Mating mounting tabs are designed for the multiple purposes of aligning and attaching the 2 halves of the detectors to each other around the beam pipe, guiding the insertion of the MPC-Ex detector into the piston holes and precisely positioning the MPC-Ex's in the piston holes.

Installation of the MPC-Ex detectors will require scaffolding, a custom designed insertion/installation tool, and a rigging fixture to lift the upper and lower halves onto the insertion/installation tool. Locating guide

MPC-Ex Partial Assembly for Run 14

The partial detector planned for the MPC-Ex engineering run during Run 14 will be assembled and installed as follows:

- A single station will be installed in the MMS piston hole.
- The partial detector shall be a full mechanical assembly of tungsten plates and spacers and shall have both upper and lower covers.
- 4 of the 8 lower tungsten plates will have carrier boards laminated to them; the other 4 lower tungsten plates will not have carrier boards.
- All 8 upper tungsten plates will be assembled without carrier boards.

- Both the upper and lower sections of the will have their Delrin closure plates installed.
- Approximately 12 micromodules will be installed on the 4 carrier boards. Exact number, location and orientation will be determined by MPC-Ex experts at assembly.
- The anti-squirm will be installed for run 14.
- The insertion/installation tool and lifting tool will be designed and used for installing the partial detector in run 14.
- Cables, fiber optics and cooling supplies will be adequate to support the installed electronics at assembly as determined by MPC-Ex experts. Routing of cables to and from detector, front end modules and control rack will be accomplished as worker planned work by PHENIX technicians and MPC-Ex experts.

Communication between MPC-Ex control rack and rack room will be accomplished using existing MuTrigger trunk cables.

(see PHENIX Work permit DRL-2013-14 for details concerning the installation of the MPC-Ex detector itself, this work permit describes installation of the electronics control rack and front end modules, only)

Control Rack and Front End Modules Installation

(Note: the PHENIX IR 12 crane is normally locked out during RHIC runs, including the time period prior to the access required for this installation. Use of the IR Crane will be required to lift the MPC-Ex South Control Rack to its intended permanent location. The path of crane motion shall be carefully planned out by trained PHENIX technician and PHENIX engineers so that at no time will components of the crane itself nor the load being lifted nor any lifting tools and equipment to be used in the lift, come in close proximity to any flammable gas containing components of any PHENIX detector subsystems.)

Install the MPC-Ex Control Rack on top of the existing South MuTrigger racks and next to the existing MPC South rack as follows:

1. The MPC-Ex South control rack shall be assembled by PHENIX electrical techs prior to a convenient 8 hour access period during the early part of run 14.
2. Make sure that no unnecessary personnel are in the vicinity of the MMS.
3. Bring the assembled MPC-Ex south rack to the IR floor area south of the PHENIX East Carriage and east of the MuID collars
4. Unlock the crane and move it to a position directly above the rack.
5. Lower the 1 ton hook and attach appropriate slings and rigging hardware to the rack for lifting.
6. Lift the rack to its intended permanent installed location.
7. Fasten the rack to its mount and remove all lifting equipment/hardware.
8. Attach all power, signal and control cables

9. If the MPC-Ex FEM's are being installed during the same access period as the MPC-Ex control rack then move the IR Crane to a location directly above the FEM installation area. (If not, then move the IR Crane to its parking location in the south west corner of the IR and lock the crane out of service.)

Install the MPC-Ex FEM's on the east vertical face of the MMS "teacup" as follows:

1. The MPC-Ex South FEM's shall be assembled by PHENIX electrical techs prior to a convenient 8 hour access period during the early part of run 14 (note: this may or may not be the same access period utilized .
2. Make sure that no unnecessary personnel are in the vicinity of the MMS.
3. Bring the assembled MPC-Ex FEM's to the IR floor area directly below its intended installation location.
4. If the MPC-Ex FEM's are being installed during a different access period then the MPC-Ex control rack then unlock the IR Crane and move the IR Crane to a location directly above the FEM installation area.
5. Lower the 1 ton hook and attach appropriate slings and rigging hardware to the FEM's for lifting.
6. Set and anchor an extension ladder to allow the installing PHENIX technician access to the FEM installation area.
7. Lift the FEM's to their intended permanent installed location.
7. The installing technician shall ascend the ladder taking care to maintain 3 point contact at all times during ascent, installation and descent.
8. Fasten the FEM to its mount and remove all lifting equipment/hardware.
9. Attach all power, signal and control cables.
10. Remove the ladder from the IR.
11. Move the IR Crane to its parking location in the south west corner of the IR and lock the crane out of service.

Closeout

After installation is complete, document and record any lessons learned in this initial installation. Sign and close out the MPC-Ex work permit.

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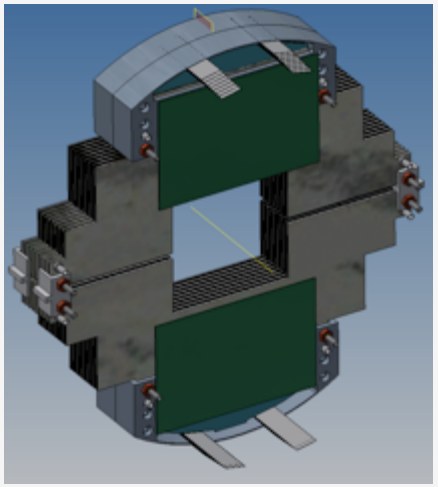
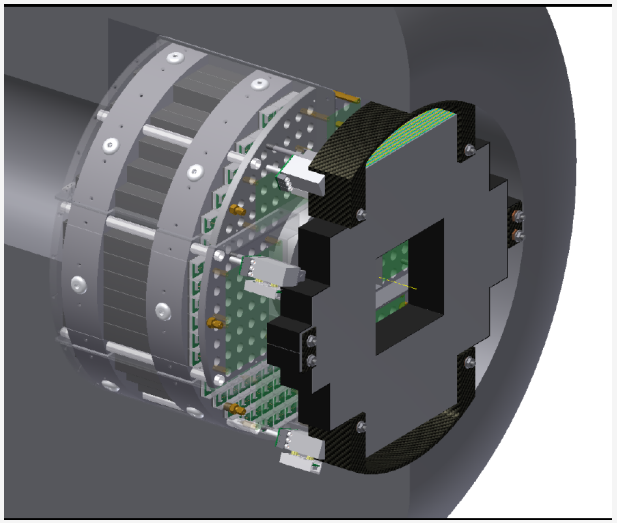
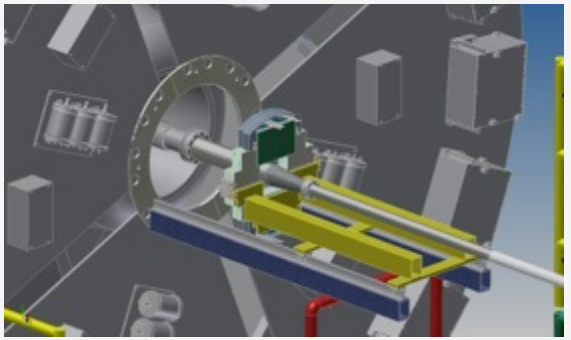
Run 14 MPC-Ex Electronics Installation Plan







February 25, 2014

Don Lynch

PHENIX

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Current Plan for partial MPC-Ex Installation for Run 14

For Run-14 the goal will be to install four mechanically complete layers of the MPC-EX for the bottom half, the other 4 tungsten only layers on the bottom half and 8 tungsten only layers on the top half (16 tungsten plates) in the south muon magnet piston. Four layers will have carrier boards (bottom $\frac{1}{2}$ only, top $\frac{1}{2}$ will be tungsten plates only), and those carrier boards will be partially populated so that we have partial coverage in azimuth with full coverage in depth.

Having a complete installation in azimuth will make the detector mechanically complete and effectively "close off" the piston hole. This will allow us to test the cooling, as well as see if the trapped neutron flux we see in simulations causes any problems.

The south arm was chosen because the north arm may not move during this shutdown. This will require the redesigned anti-squirm device to be built and installed on the beam pipe. The MPC light boxes will need to be moved for the south.

For cooling we will use the existing dry air system, we will need to determine the manifolds, supply lines and exhaust plan.

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Subassemlies:

ROC Micro-modules: There are normally 12 of these for each half layer, 392 total for both MPC-Ex's. Approximately 12 of these will be included in the Run 14 partial installation. Each ROC micro-module is assembled as a PC board, a silicon sensor module and a ceramic sheet which are all glued together in a gluing fixture. The sensor is then sent to instrumentation to have its sensor leads wire bonded to the electrical distribution pads on the PC board.

Carrier boards: Produced outside.

Tungsten/Carrier board modules: The carrier boards are fastened to 2mm thick tungsten plates at PHYSICS using a positioning fixture and double sided adhesive.

Upper and Lower, North and South Detector segment assemblies are then mechanically assembled. Each is made of 8 T/C modules and a single Delrin cover plate (design identical to tungsten plates). The space between tungsten plates is made uniform by threaded spacers and the entire assembly is held together with threaded rods on which the spacers ride. The top and bottom modules have their upper and lower ends protected by a Delrin "cradle" which provides extra support, protection for the signal cables and support for the power supply/PC interface boards.

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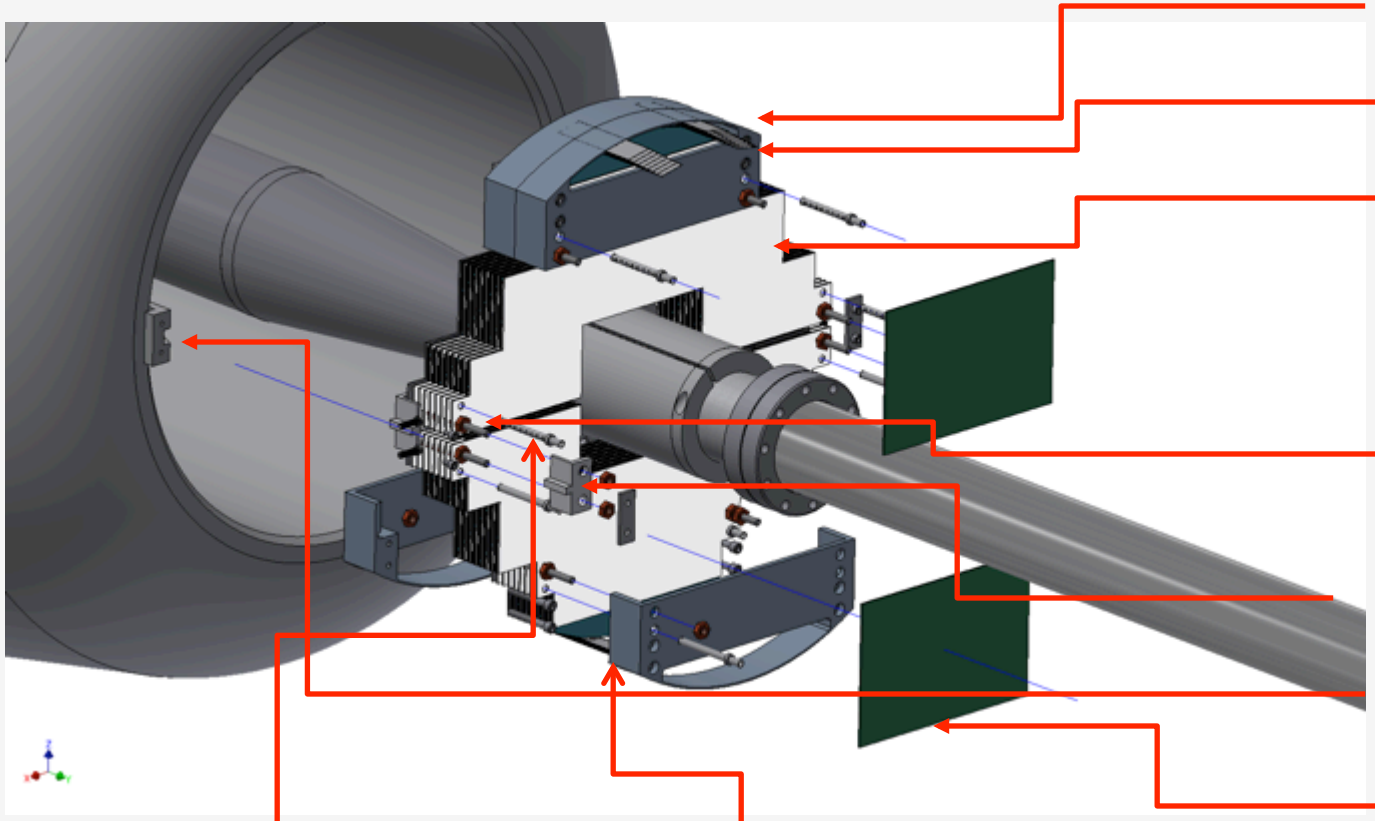
MPC-Ex Exploded view



Upper covers

Signal Cable pigtails

8 layers of tungsten & detector electronics backed by Delrin cover (top and bottom halves)

Threaded rods and spacers

Mounting tabs

Mounting clips

LV distribution boards

Lower covers

Cooling air manifolds

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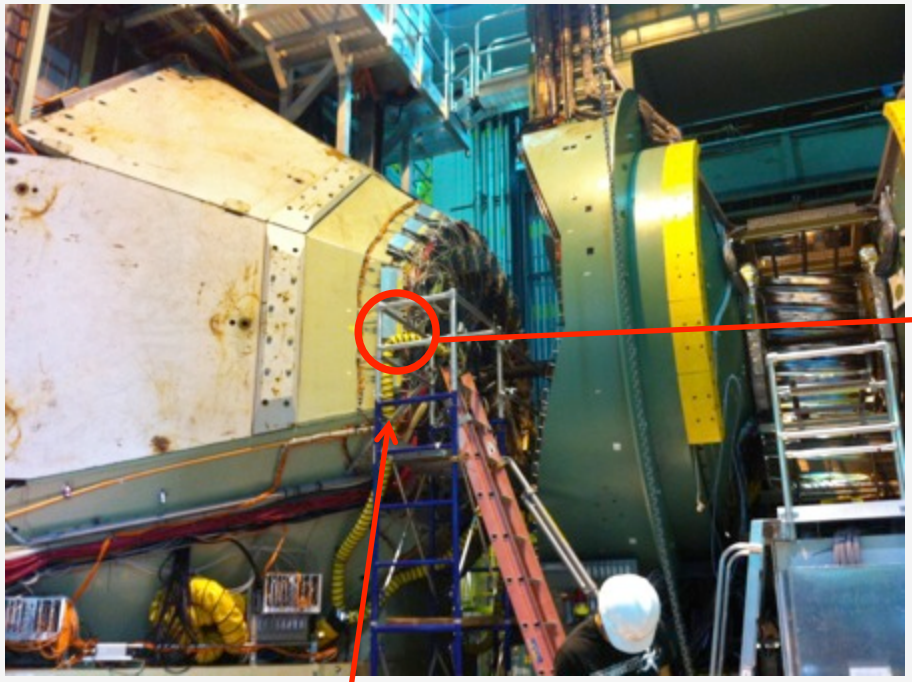

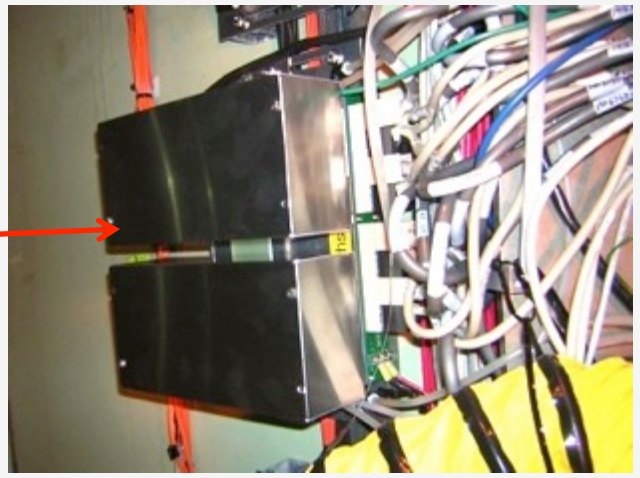

Front end electronics enclosures mounted on existing MuTrigger front end electronics boxes.

Scaffolding in place from MuTr maintenance

MPC Flat cables replaced with round cables (Done last year)

MPC Cables rerouted

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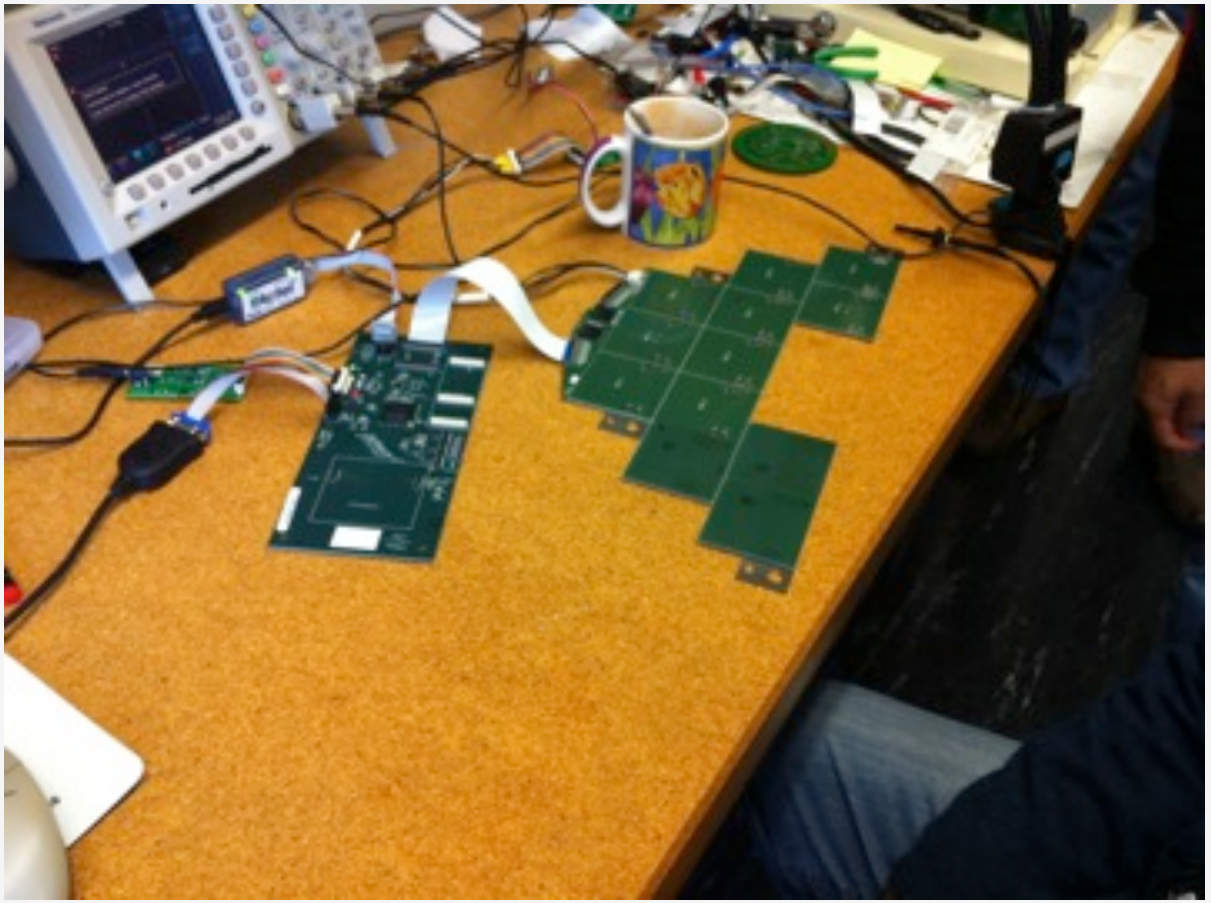

1st test of front end module board with laminated tungsten/carrier board & partial micromodules

MPC-EX Racks

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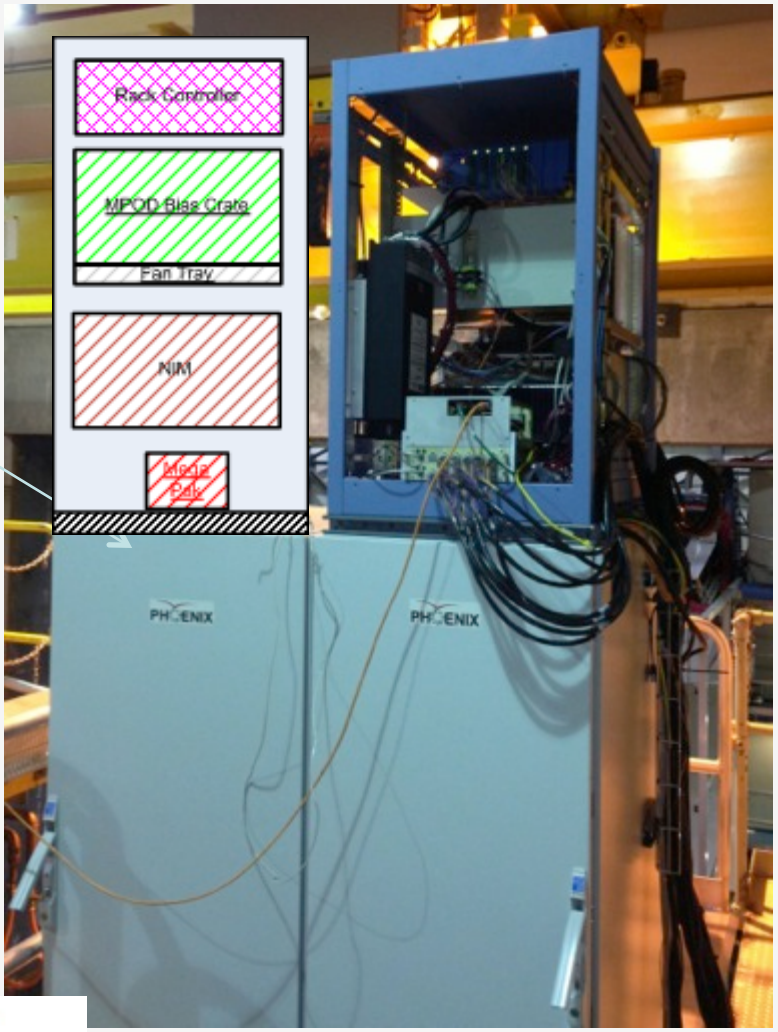
- Same 1m x 1m type as MPC with 31" of vertical rack space.
- Mounted on top of SMT5 and NMT5 racks.
- Contain low voltage, NIM crate and bias.



SMT5

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Installation

November 1-15 2013

All detector components were installed. Cable and cooling routing was field fit by PHENIX technicians. Station 1 scaffolding was removed ~ 11/15/2013.

~March 1, 2014

Install MPC-Ex rack on MMS MuTrigger platform, using crane install FEM's on east vertical face of MMS "teacup".